

CAMBARUS (EREBICAMBARUS) MACULATUS, A
NEW CRAYFISH (DECAPODA: CAMBARIDAE)
FROM THE MERAMEC RIVER
BASIN OF MISSOURI

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Abstract.—*Cambarus (Erebicambarus) maculatus* is described from the Meramec River and its tributaries in eastern Missouri. Its speckled color pattern, which is unique in the genus *Cambarus*, prompted the vernacular name, "Freckled Crayfish." It may be distinguished from its closest relatives, *C. (E.) hubbsi* Creaser (1931) and *C. (E.) rusticiformis* Rhoades (1944), by the color pattern and by the tapering central projection of the first pleopod of the first form male.

So long as the crayfish described here retains its color pattern, it is one of the most easily recognized of any of the American species. Only one other, *Procambarus (Girardiella) tulaneii* Penn (1953), an inhabitant of the Ouachita River Basin in Arkansas and Louisiana, exhibits a similar freckled pattern, but the chelae of the males of that species bear a heavy beard on the mesial surface of the palm; moreover, the pleura of members of both sexes are broadly rounded rather than being acute as they are in this crayfish from Missouri.

Closely allied to the new species from the Meramec River Basin, and occupying contiguous, if not overlapping, ranges are the troglobitic *Cambarus (Erebicambarus) hubrichti* Hobbs (1952) and a probable ecological equivalent, *C. (E.) hubbsi* Creaser (1931), which seems to be limited to the White and St. Francis watersheds of Missouri and Arkansas.

Cambarus (Erebicambarus) maculatus,
new species
Figs. 1, 2

Cambarus hubbsi.—Williams 1954:908, fig. 233 [in part]. Freckled Crayfish, Pflieger, 1987a:23; 1987b:7.

Diagnosis.—Body pigmented; eyes well

developed. Rostrum, with thickened lateral carinae, broad basally, tapering gradually to base of acumen where studded with paired, conspicuous, dorsally projecting, corneous tubercles; apex of acumen with similar, dorsally directed, strong tubercle. Postorbital ridges thickened and capped at anterior extremity with prominent, corneous, sometimes spiniform tubercle. Suborbital angle obtuse, usually rounded. Cervical spines represented by rounded, inconspicuous tubercles. Areola of adults 3.8 to 5.9 times as long as wide and comprising 37.0 to 40.6% of entire length of carapace (43.8 to 49.0% of postorbital carapace length), and bearing 3 to 6 punctations across narrowest part. Chela with single row of 9 to 12 (usually 10) often poorly defined tubercles on mesial surface of palm, remainder of which punctate. Fingers with tubercles restricted to opposable margins; fixed member with third tubercle from base distinctly larger than others on either finger (size difference not evident in regenerated chelae); both fingers with well defined dorsomedian longitudinal ridges. Prominent subacute hook on ischium of third pereopod distinctly overreaching basioischial articulation, and opposed by tubercle on basis. Pleura of second through fifth abdominal segments tapering to acute or subacute apices. First pleopod

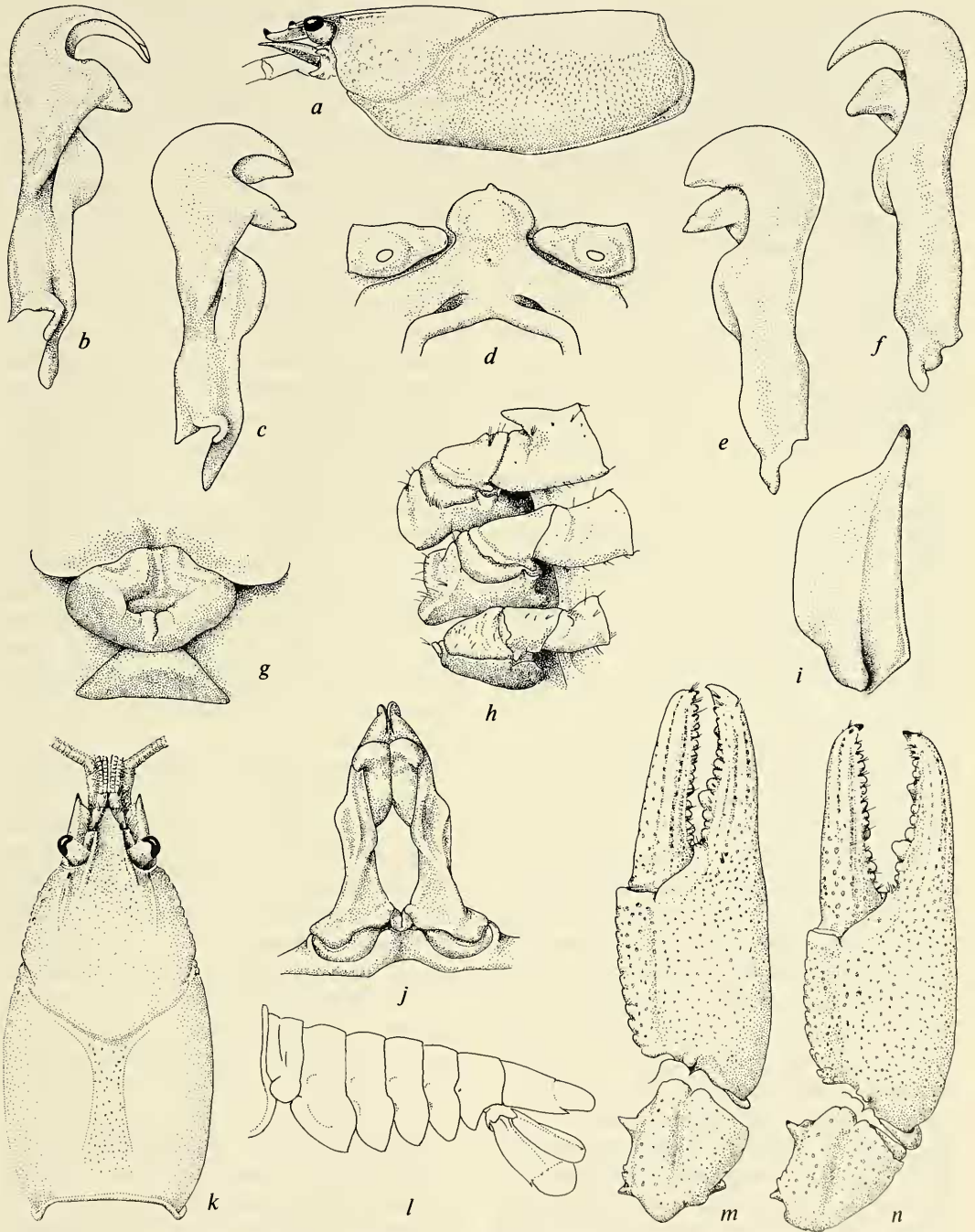


Fig. 1. *Cambarus (Erebicambarus) maculatus* (all from holotype except c and e which are from paratypic male, form II, and g, m which are from allotype): a, Lateral view of carapace; b, c, Mesial view of first pleopod; d, Epistome; e, f, Lateral view of first pleopod; g, Annulus ventralis and adjacent sternites; h, Basal podomeres of third, fourth, and fifth pereiopods; i, Antennal scale; j, Caudal view of first pleopods; k, Dorsal view of carapace; l, Dorsolateral view of abdomen; m, n, Dorsal view of distal podomeres of cheliped.

of first form male terminating in two elements: gently curved, scythelike, tapering central projection with apex, lacking subapical notch, directed caudoproximally; and mesial process inflated and directed caudolaterally with apex situated lateral to apex of central projection although reflexed somewhat mesially. Color tan to olive tan with darker brown to almost black spots. First pleopods present in female.

Holotypic male, form I.—Cephalothorax subovate in cross section; carapace rather strongly depressed (Fig. 1a, k), its greatest width decidedly broader than height at caudodorsal margin of cervical groove (20.1 and 13.0 mm). Rostrum with conspicuously thickened, elevated, and tapering lateral carinae studded with obliquely set, dorsally disposed, corneous tubercles, latter clearly marking base of acumen which, bearing prominent corneous, dorsally directed tip, reaching about midlength of ultimate podomere of antennular peduncle. Subrostral ridges rather weak and evident in dorsal aspect along slightly less than basal third of rostrum. Suborbital angle obtuse. Postorbital ridges weak except anteriorly where bearing upturned, corneous tip. Branchiostegal spine obsolete. Areola 5 times as long as broad, with 4 or 5 punctations across narrowest part; length of areola 38.7% of total length of carapace (46.5% of postorbital carapace length). Cervical spine represented by inconspicuous tubercle no larger than others nearby. Carapace densely punctate dorsally, becoming granulate to tuberculate laterally, especially from area of cervical tubercle anteriorly.

Abdomen shorter than carapace (33.7 and 37.7 mm); pleura (Fig. 1l) tapering ventrally, all acute. Cephalic section of telson with lateral margins comparatively strongly converging posteriorly and bearing single prominent, fixed spine in each caudolateral corner; caudal section narrow and appearing remarkably small. Proximal podomere of uropod lacking spines on both lobes; distally subtruncate mesial ramus with poorly

developed median keel ending in small pre-marginal spine.

Cephalomedian lobe of epistome (Fig. 1d) broadly rounded with small cephalomedian projection, margin somewhat thickened, and central part of lobe elevated ventrally; main body with distinct fovea, and epistomal zygoma rather weakly arched. Ventral surface of proximal podomere of antennule with very small tubercle at about base of distal fourth and slightly lateral to median line of podomere. Antennal peduncle devoid of spines and tubercles; flagellum broken, but probably reaching fifth or sixth abdominal tergum. Antennal scale (Fig. 1i) about 2.5 times as long as broad with mesial and lateral margins subparallel for more than half length, distomesial margin of lamellar area tapering to join prominent distolateral spine which attaining about same level anteriorly as apex of rostrum. Mesial half of ischium of third maxilliped with linear clusters of tubercles bearing long, stiff setae; setae scattered over lateral half short and inconspicuous; distolateral extremity of podomere not produced.

Right chela (Fig. 1n) about 2.5 times as long as wide, moderately depressed; palm, with length of mesial margin subequal to greatest width of podomere and bearing row of 10 very low tubercles; remainder of palm densely punctate and lacking tubercles other than usual ones associated with articulation of adjacent podomeres. Both fingers with low but clearly defined dorsal and ventral median longitudinal ridges. Arched fixed finger rather smaller than those of some of its congeners and with row of 9 (10 on left) tubercles, third from base largest, rather evenly distributed along opposable margin; usual additional large tubercle situated below row just proximal to distal 3 tubercles of row; finger otherwise unremarkable. Typically heavy dactyl with row of 11 (12 on left) tubercles on opposable margin and offset larger one slightly below row and immediately distal to gap between third and fourth (fourth and fifth on left) tubercles

from base; gap lying almost opposite largest tubercle on opposable margin of fixed finger. Minute denticles abundant on opposable margins of fingers of chelae of many crayfishes sparse and largely limited to single fine, short row extending between distalmost tubercle and corneous tip of finger. Mesial surface of dactyl lacking tubercles, even basally; podomere entirely punctate except for those on opposable margin.

Carpus of cheliped longer than broad (13.4 and 9.5 mm), with moderately deep, oblique, longitudinal furrow dorsally flanked by punctations; mesial surface with prominent mesiodistally directed spine and single (2 on left) small tubercle near proximomesial base; ventral surface polished and with single tubercle situated on distal margin mesial to ventrolateral articular knob. Merus with 2 small dorsodistal tubercles; ventral surface with mesial row of 7 (left with 9) corneous tipped spines and 2 (1 on left) representing lateral row of other crayfishes; lateral and mesial surfaces sparsely punctate. Basioischial podomere with row of 4 poorly developed tubercles ventromesially.

Hook on ischium of third pereopod only (Fig. 1h), acute, overreaching basioischial articulation, and opposed by tubercle, flanked by setiferous punctations, on basis. Coxa of fourth pereopod with prominent caudomesial boss, caudal face of which in almost same plane as remainder of caudal surface of podomere. Boss absent from coxa of fifth pereopod. First pleopods (Fig. 1b, f, j) reaching coxae of third pereopods, symmetrical, and with small gap between their bases. See "Diagnosis" for description of terminal elements.

Allotypic female.—Excluding secondary sexual characteristics, differing in only few minor respects from holotype: telson and uropods decidedly hirsute; mesial lobe of proximal podomere of uropod produced caudally in spine; tubercle on ventral surface of basal podomere of antennule situated slightly more proximally; chela (Fig. 1m) proportionately narrower, about 2.7

Table 1.—Measurements (mm) of *Cambarus (E.) maculatus*.

	Holo-type	Allo-type	Morpho-type
Carapace:			
Entire length	37.7	36.0	32.0
Postorbital length	31.4	29.0	26.6
Width	20.1	18.9	17.2
Height	13.0	12.7	11.2
Areola:			
Width	2.9	2.4	2.1
Length	14.6	14.2	11.5
Rostrum:			
Width	5.2	5.2	5.0
Length	6.3	7.0	5.4
Right chela:			
Length, palm mesial margin	14.2	13.2	10.5
Palm width	14.5	11.9	11.1
Length, lateral margin	37.1	32.6	25.6
Dactyl length	18.3	16.6	13.2
Abdomen:			
Width	17.6	17.7	13.5
Length	33.7	31.6	27.7

times as long as wide; mesial margin of palm with row of 11 ill-defined tubercles. Fixed finger with row of 13 (left with 12, proximalmost lacking) tubercles along opposable margin, fifth from base largest; opposable margin of dactyl with row of 13 (left with 14) tubercles and offset 1 following gap; ventral surface of merus of cheliped with mesial row of 8 tubercles (9 on left) and lateral row represented by only 1 tubercle. (See Table 1.)

Annulus ventralis (Fig. 1g) firmly fused to sternite XIII, irregularly ovate with greater axis lying transversely, about 1.7 times as broad as long; cephalomedian trough moderately deep but not flanked by conspicuous cephalolateral prominences; transverse sulcus well defined with tongue extending dextrally, disappearing under high, longitudinally creased caudal wall. Postannular sclerite only slightly narrower than annulus and only little more than half as long.

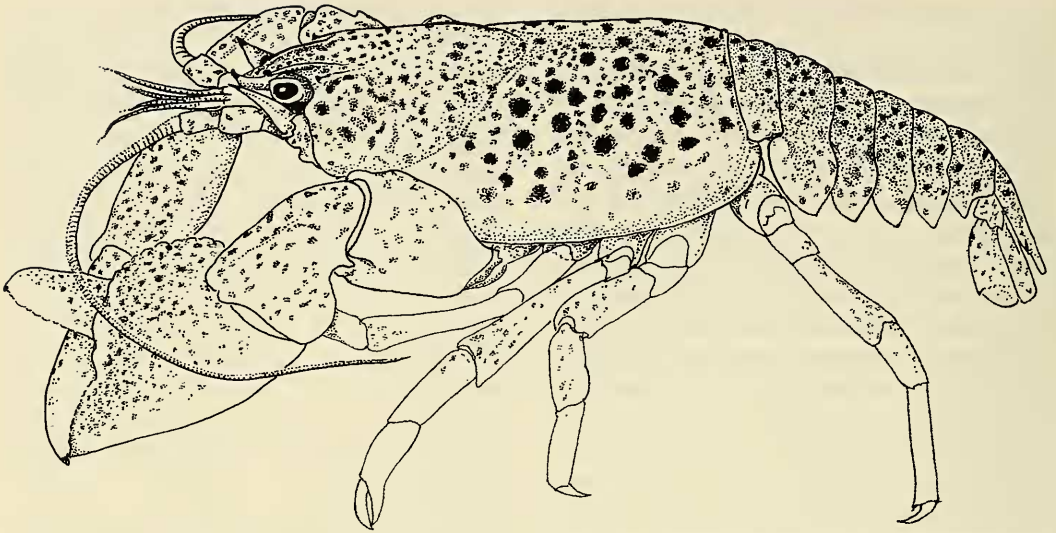


Fig. 2. Dorsolateral view of first form male of *Cambarus (E.) maculatus* from Huzzah Creek, Crawford County, Missouri.

Morphotypic male, form II.—Differing from holotype in following respects: apical spines on postorbital ridges directed cephalolaterally and only slightly dorsally; telson with less convergent margins, and anterior section with pair of movable spines mesial to fixed ones in caudolateral corners; mesial lobe of basal podomere of uropod with prominent caudally projecting spine; mesial margin of palm of chela with row of 14 tubercles (left with 10); opposable margin of fixed finger with row of 8 tubercles (left with 10); opposable margin of dactyl with row of 11 tubercles and offset one (left with 10 and 1); row of minute denticles on opposable margins of both fingers longer and more conspicuous; ornamentation of more basal podomeres within ranges noted in holotype; hooks on ischia of third pereopod much less well developed, not reaching basioischial articulation, but small opposing tubercle on basis clearly evident. First pleopods (like Fig. 1c, e) differing from that of holotype chiefly in structure of central projection which much more massive, comparatively shorter, and non-corneous. (See Table 1.)

Color notes (Fig. 2).—Carapace yellowish tan to pale orange tan with very dark brown to black spots, largest of which subcircular and occurring dorsolaterally over branchiostegites and in posterior part of areola. Dorsal surface of abdomen, telson, and uropods with yellow or tan base infused with brown, thus yellowish to orange brown, with dark spots similar to, but smaller than, those on carapace. Background color of chelipeds often much paler, sometimes almost cream, and, except ventrally, bearing dark brown to black spots of varying sizes and shapes; only few of those on dorsal part of carpus and merus as large as those on branchiostegites. Second through fifth pereopods similarly colored but with spots small and more sparse.

Size.—The largest specimen available is a first form male from Huzzah Creek in Crawford County having a carapace length of 44.4 (postorbital carapace length 37.2) mm. The smallest first form male, from Washington County, has corresponding lengths of 24.6 and 20.4 mm. The smallest ovigerous female available has a carapace length of 32 mm (postorbital length 27.8

mm), the largest, 36 and 30.6 mm, respectively.

Type locality.—Hazel Creek at Route C, 8 miles (12.8 km) northeast of Courtois, Washington County, Missouri (T. 36N, R. 1W, SE¼ Sec. 24). The specimens collected there were found beneath rocks in the plunge pool just below the concrete road crossing. At low water this pool measured 14 m in width and 8.4 m in length, with a maximum depth of 1 m. At this locality, *C. (E.) maculatus* occurred in association with *Orconectes (Procericambarus) punctimanus* (Creaser 1933), *O. (P.) luteus* (Creaser, 1933) and *O. (P.) medius* (Faxon, 1884). The latter species comprised 73.2% of our collections, while *C. (E.) maculatus* comprised 5.5%, the least common of the four species.

Disposition of types.—The holotype, allotype, and morphotype (USNM 219292, 219293, and 219280, respectively) are deposited in the National Museum of Natural History, Smithsonian Institution. Of the paratypes, 3♂I, 2♂II, 1♀, and 1j♀ are in the collection of Ronald D. Oesch; the remaining ones are in the National Museum of Natural History.

Range and specimens examined.—This new crayfish appears to be restricted to the Meramec River and its tributaries in eastern Missouri (Fig. 3) where it has been found in the following localities: Crawford County: (1) Huzzah Creek at end of Rte E (T. 38N, R. 3W, Sec. 11), 1♂I, 4 Mar 1977, W. L. Pflieger, A. Buchanan; (2) Meramec River at Cooks Station (T. 36N, R. 5W, NE¼ Sec. 6), 2♀, 12 Oct 1984, WLP, 1♂I, 1♂II, 18 Jul 1985, WLP, 1♂I, 6 May 1986, WLP; (3) Meramec River at Hwy 8, 8.75 mi (14 km) W of Steelville (T. 37N, R. 5W, SW¼ Sec. 6) 2♀, 1j♀, 25 Aug 1968, J. E. Cooper, M. R. Cooper, 3♂I, 2♂II, 24 Oct 1985, WLP, 3♂II, 2♀, 5 May 1986, WLP, 1♂I, 16 Apr 1987, R. D. Oesch; (4) Huzzah Creek (T. 37N, R. 2W, Sec. 6), 3♂I, 1♀, 23 Oct 1986, WLP; (5) Trib of Huzzah Creek 1.5 mi (2.4 km) N of Dillard, 1♂II, 10 Sep 1955, Nell Crenshaw, John Crenshaw; (6) Huzzah

Creek below Hwy 8, 1♂I, 1♂II, 1♀, 1j♂, 9 May 1987, RDO. Franklin County: (7) Meramec River at Meramec State Park (T. 40N, R. 2W, Sec. 13), 1♂I, 4 Mar 1977, WLP, AB. Washington County: (8) Type locality, 5♂I, 2♀, 18 Oct 1984, WLP, 1♂I, 2♀, 5 May 1986, WLP, 1♂I, 2♀, 4j♂, 25 Mar 1985, WLP; (9) Big River at Hwy 21, 3 mi N of Caledonia (T. 36N, R. 2E, Sec. 25), 1j♀, 25 Aug 1968, JEC, MRC, 1♀, 1j♂, 17 Oct 1984, WLP; (10) Mill Creek at Rte N (T. 36N, R. 3E, NE¼ Sec 22) 2♂I, 25 Mar 1985, WLP; (11) Fourche Renault Creek at Rte AA, 1 mi W of Summer Lake (T. 38N, R. 1E, SW¼ Sec 34), 1♂I, 22 Oct 1986, WLP; (12) Mine Breton Creek at Hwy 8, 1♂I, 11 Apr 1984, RDO; (13) Cedar Creek at Hwy 32, 1.5 airmi (2.4 km) ESE of Caledonia, 1j♂, 18 Aug 1948, ABW, ABL, 1♀, 21 Jun 1987, RDO; (14) Big River, 8.6 mi (13.8 km) S of Potosi, 1♂II, 2j♂, 18 Aug 1948, ABW, ABL; (15) Mineral Fork at W Hwy 57 bridge, 1♂II, 7 Jul 1979, J. F. Payne; (16) Big River at Hwy 21, 1♂II, 1♀, 7 Jul 1979, JFP.

Variations.—Barring variations that have almost certainly resulted from injury, regeneration, or abrasion that often appear to be commensurate with the length of the period since the most recent molt, our specimens exhibit remarkable uniformity in both mensural and meristic qualities. Such ratios as length of areola/total length of body yielded a mean of 38.6 ± 1.653 ; length of the areola/postorbital carapace length, 46.3 ± 1.125 ; and areola length/areola width, 4.9 ± 0.597 . Moreover, ratios involving the length of the chela, its maximum width, and length of the palm, even when regenerated chelae were considered, show little variation. Similarly the differences in the numbers of tubercles on the body and the various podomeres of the chelipeds are comparatively small, hardly exceeding the variations pointed out in the descriptions of the primary types. Perhaps the most conspicuous variation occurs in the relative development and numbers of tubercles on the regenerated chelipeds. Such chelae can be

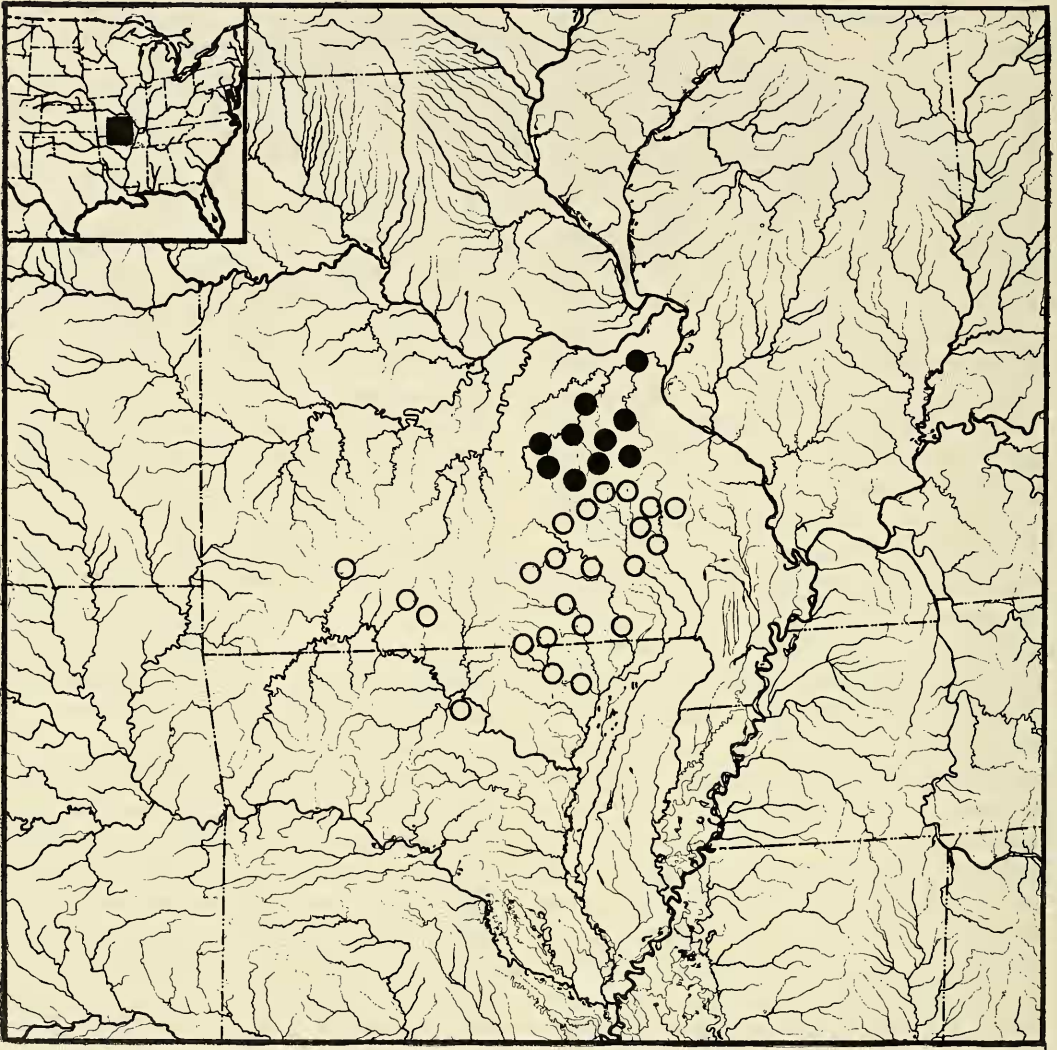


Fig. 3. Distribution of *Cambarus (E.) maculatus* (black circles) and *Cambarus (E.) hubbsi* (open circles).

recognized by the absence of an enlargement of the third, fourth, or fifth tubercle from the base on the opposable margin of the fixed finger. While it is likely that such a difference does not exist in a cheliped that was lost and regenerated in the earlier instars, should a large tubercle be wanting on the opposable margin of that finger, one may be sure that the appendage is a regenerated one, and is likely to bear a larger number of tubercles on that and the corresponding margin of the dactyl.

Ecological notes.—*Cambarus (E.) mac-*

ulatus is largely restricted to a deeply dissected region of the eastern Ozarks known as the Couteois Hills. The bedrocks of this region consist principally of limestones and dolomites of the Gasconade and Potosi formations. Chert gravel weathered from these rocks is the principal bottom type in the streams. Much of the region is sparsely populated and is within the boundaries of the Mark Twain National Forest. The streams are very clear, with permanent flow maintained by numerous springs. *C. (E.) maculatus* occurs in streams ranging in size from

order 3 to 7, but is most abundant in those of order 4 or 5. It is usually found in pools, at depths of 20 cm or more, beneath rocks that are well seated in gravel. Its presence is often revealed by small piles of gravel pushed out of the shallow cavities that it excavates. The habitat and habits of this species are not notably different from those of *C. (E.) hubbsi*.

In 12 collections made by one of us (WLP), five other species of crayfishes, all belonging to the genus *Orconectes* occurred. The species and number of collections were: *O. (Procericambarus) luteus*, 12; *O. (P.) punctimanus*, 9; *O. (P.) medius*, 8; *O. (Billecambarus) harrisonii* (Faxon 1884), 4; and *O. (P.) hylas* (Faxon 1890), 2.

Life history notes.—In our collections from the months of October, March, and April, 18 of 20 males were Form I, while 5 of 6 males collected during the months of July to September were Form II. Three ovigerous females occurred in collections made on 5 May 1986. These females measured 32, 34, and 36 mm carapace length and carried 67, 63, and 127 eggs, respectively. The eggs were about 1.8 mm in diameter and were grey to nearly black in color.

Relationships.—*Cambarus (Erebicambarus) maculatus* has its closest affinities with *C. (E.) hubbsi* and *C. (E.) rusticiformis* Rhoades (1944). Differing from their other congeners, these three crayfishes with strongly depressed bodies possess rostra, the lateral carinae of which end abruptly at the base of the acumen and usually bear marginal tubercles at their apices. The carinae are thickened and diverge at their bases. All three have rather broad, moderately densely punctate areolae. The rather weak tubercles along the mesial margin of the palms of their chelae are largely confined to a single row. All three exhibit a striking similarity in their abdominal pleura, which taper to acute angles (apices often rounded) that, when the abdomen is extended, are directed almost ventrally. Similarly structured pleura, which may be found to be associated with adap-

tations to lotic habitats, occur in the Astacidae and in members of the cambarid genera *Cambaroides* and the monotypic *Barbicambarus cornutus* Faxon (1884), all of which are at least primarily stream dwellers.

The “freckled” color pattern alone serves to distinguish this crayfish from *C. (E.) hubbsi* and *C. (E.) rusticiformis*, but in preserved specimens in which the pigment has completely faded, distinguishing between them becomes more difficult. First form males of the new species are unique among them in that the central projection of the first pleopod tapers to an acute tip, whereas in the other two the comparatively broad distal part of the element bears a subapical notch. Except for the color patterns, we have been unable to discover a single character that will serve consistently to distinguish the second form males, females, and juveniles of the three, although the obliquely set marginal spines of the rostrum that project dorsally rather than anterodorsally can usually be relied upon to recognize most members of *C. (E.) maculatus*. The recognition of the allopatric (with respect to the other two) *C. (E.) rusticiformis*, which is restricted to streams east of the Mississippi River (where it is largely, if not entirely, restricted to the Cumberland Basin, and thus their ranges are not even contiguous) presents no problem.

Although *Cambarus (E.) hubbsi* is restricted largely, if not entirely, to the White and St. Francis watersheds of Missouri and Arkansas, there is a Form I male of this species at the National Museum of Natural History (USNM 219315) which was reportedly collected from the Meramec River east of Eureka, Missouri, in 1934. If this record is valid, the range of *C. (E.) hubbsi* overlaps that of *C. (E.) maculatus*, and recognition of the identity of bleached second form males and females of the two, at least sometimes, might be problematical. Recent collections at this locality, however, included specimens of only the latter species.

There can be little doubt that before the

ancestral *Erebicambarus* stock crossed the Mississippi River (Hobbs 1969:110) to become established in the Meramec, St. Francis, and White river basins, it had already acquired a mien shared by the segment of the stock that was left behind and that gave rise to the modern *C. (E.) rusticiformis*. In our view then, the close resemblance existing between the latter, *C. (E.) maculatus*, and *C. (E.) hubbsi*, has resulted from a retention of features that have been little altered during the course of their long-time, continuous occupancy of similar ecological niches rather than from convergence in the three undergoing similar adaptations independently. Of the three *Erebicambarus* occurring west of the Mississippi River (Ozark Region), only *C. (E.) hubrichti* exhibits features that appear to us to be markedly different from those we believe to have been characteristic of the pioneering ancestor, and we suggest that these are associated with its ancestors becoming adapted to a spelean environment.

At least two features of *C. (E.) maculatus*, unique in the subgenus *Erebicambarus*, suggest that this crayfish is farther removed from the ancestral stock than is *C. (E.) hubbsi*. These are the speckled color pattern and the tapered central projection of the first pleopod in first form males.

Acknowledgments

Appreciation is extended to Ronald D. Oesch, who is associated with the Cooperating Schools of the St. Louis Suburban Area, for lending us specimens of *C. (E.) maculatus* from his collection and to other collectors mentioned under "Range and specimens examined" who have donated specimens to the Smithsonian Institution. For their helpful comments on the manuscript, acknowledgment is also made with thanks to C. W. Hart, Jr., of the National Museum of Natural History, and to Douglas G. Smith, of the University of Massachusetts.

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